GIS/GPS MORE THAN ALPHABET SOUP

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Many people today seem to put GIS (Geographic Information Systems,) and GPS (Global Positioning System) into the same alphabet soup. When in fact, they serve very different functions. In this article I hope to clear the water a little and show how these uniquely different systems work very well together.

In the last article we talked about some of the differences between types of GPS receivers. I identified four general types of receivers:
1. Navigation Grade
2. Mapping or Inventory Grade
3. Survey Grade
4. Specialty and Military Grade

In this article I would like to narrow our focus on "mapping or inventory grade" GPS receivers, and their role in a GIS. This is one of the fastest growing applications of this new technology and it carries with it the most profound impacts on how we will manage corporate data in this new millennium. Whether you are managing a sign inventory, a striping log, or a wetland, GIS may be just the tool for you and GPS may be the key that will help you to use it.

Before we dive into this quarter’s column, I am going to indulge myself in a brief tirade on what I call technobabble. I find that one of the most difficult elements of applying new technology is understanding the terminology. Words should clarify and communicate the concepts involved in the technology. All too often they seem to be abstract, ill chosen, or adapted form another field. One of the problems is that these systems are so new and dynamic that the words with the exact meaning of the new concepts don’t always exist. Words are then created or borrowed from other disciplines that describe similar concepts and their meanings are expanded on. As a result, words for the new technology may have a subtle, or not so subtle, difference from older established fields. Add to this, the dynamic state of the technology itself and you have a real potential for miscommunication between disciplines and individuals unfamiliar with the new technology. At times, it is like learning another language where the meaning of the words change as subtly as dialects do within a single language. Words, such as "geospatial coordinates", to a geodesist may paint a very different picture in the mind of a cartographer or GIS manager. As an example of this, as you read this article you will encounter words that will be defined by the surrounding text. Your agency may use different terminology to describe similar concepts and functions.

Another problem is that you won’t find most new technical words like geospatial in a regular dictionary so there isn’t a easy source of standardized definitions.

The world of GIS is a melting pot of various disciplines, cultures, and data types. The common language is geospatial coordinates (XY&Z (coordinate geometry), i.e. latitude, longitude and elevation).

I mention the topic of technobabble in hopes that it will alert you to it's existence and the ramifications that multiple definitions of terminology can have as you encounter the different dialects of technobabble within your agency.

So, what does all this GIS stuff have to do with GPS?

First, we need to answer the question, what is a GIS (Geographic Information Systems?)

In it's simplest terms, a GIS is an electronic map with information on it.

If you were to plot an outline of the State of Washington on a piece of paper and place it on a table, you would have defined a geographic area. Next, assume you were to take sheets of clear plastic with information on them about this geographic area and lay them on top of the map in layers, one on top of the other. Information on each subsequent layer is displayed in three format types, points, lines and polygons, depending on the type of data represented.

For example:

- Some layers may have topographical information showing hills, valleys, bodies of water, etc.. Other layers may have county boundaries, tribal reservations, forests or wetlands. These enclosed shapes, or areas, are commonly referred to as "polygons" (a geometric plane consisting of three or more sides.)
- Other layers may have linear representations of roads, striping logs, railroads, rivers, streams, etc.. These are referred to as "lines."
- Still other layers may have "point" information such as cities, airports, signs, culverts, and mileposts.

All information that is placed on a map (geographic) must be some type of point, line, or polygon.

Instead of using paper and plastic layers, a GIS is a computerized "system" that helps you store, manage, analyze and present your geographic information electronically.

Thus the name GIS is a compound acronym built from: geographic (map or area), information (layers of data), and the system (the computerized software system).

The glue that holds all these layers of information together and orients them properly to themselves is georeferencing. Georeferencing is a referencing system based on some X,Y and sometimes Z (length, width, height) coordinate system. For example: longitude, latitude, and elevation. I say sometimes "Z", because most GIS's currently operate in two dimensional space not 3 dimensional, but that is a topic we will discussion in subsequent issues. To assist you in understanding GIS terminology, the Association for Geographic Information has a GIS dictionary and other tools (i.e., acronym list) on their web at:

http://www.geo.ed.ac.uk/agidict/welcome.html

For example they define georeference as:
Georeference: To establish the relationship between page coordinates on a map and known real-world coordinates.

So, what makes the GIS "electronic" map more then just a "dumb" graphic or pretty drawing on a piece of paper?

Simple. Someone has taken these graphical elements and other information related to the map and referenced them to locations in the real world. What was once an artistic representation of the real world, is now a "smart" map because it knows where in the real world it's layers are located geospatially. All the layers in your GIS are glued together because they all represent the same geographic locations. This, in effect, takes all the layers of information and places them over each other so all common points are in alignment. For example, the point that a river intersects with a roadway (on the river layer), now matches the point that the roadway intersects the river (on the roadway layer), and both those points match the actual location in the real world.

A GIS can "speak" other languages besides XYZ, such as LRS (linear referencing system), but again the common language to both is georeferencing.

In a GIS you can turn the layers on and off to help display and analyze your data in various combinations and in a common format. It also provides a common language to share your data with others and too analyze your data against factors that are hard to see in a tabular format, such as a database.

For example: If I have a stretch of roadway (line) that quickly deteriorates after paving and I bring that roadway up in a GIS, I can place readings from a deflectometer on top of it (point data.) This information may lead me to turn on the soils and wetlands layer (polygons) underneath it. Since these lines, points, and polygons are all georeferenced to the same geospatial location, I can quickly align all the information and analyze the relationships between them. Now as I analyze my layered data, I discover that the roadway is failing because of the surrounding environment, not because of the materials that were used in the paving construction. This is only one of many possible applications. I am sure that you can see the value of such a system, the possibilities are unlimited.

So what does all this GIS stuff have to do with GPS?

The answer, nothing and everything. It depends on the type of data you are collecting and how your data will be ultimately used.

We defined GIS in it's simplest definition as a software system that provides the ability to manage, analyze and present your geographic information.

In it's simplest definition GPS is a satellite based measuring system.

As a GIS can be described using layers of paper and plastic, GPS can be characterized as a high tech three dimensional measuring tape. If you pulled 12,600 miles of tape from four tape measurers in geosynchronous orbit above the earth, they should intersect at a measurable location on the surface.

One system specializes in organizing and analyzing data, the other specializes in the ability to locate data. You can use GPS as a stand alone system to locate "things" (points, lines and polygons,) quickly, easily and very accurately depending the equipment and procedures you use. So in short, each system can function independent of one another, but when integrated they offer a very powerful combination.

In fact, many of the inventory grade GPS receivers today integrated some of the features found in a GIS. This seems to be a source of much confusion to many today. Though these hybrid GPS systems have some of the functionality of a GIS, they lack the power and the full funcionality of a true GIS work station. On the other hand, even thought the georeferencing of the base maps is getting more accurate all the time, a work station will never have the mobility and abilities that a GPS unit receiver has.

Some of the differences identified between GPS receivers in the last article, were accuracy and functionality. An example of the basic "navigation grade" or recreational usage of GPS would be: "I found location X,Y,Z and I can return to location X,Y,Z whenever I want too. Navigation alone makes GPS a very handy tool.

The next step in using GPS is "mapping" or "inventory grade" usage. Now that you can locate XYZ you may want to store information (attributes) that describes the things you have located there. For example: I am at location XYZ, the data element I want to locate and describe is a box culvert. Most software will even allow you to break this element down even further to "attributes" about it, i.e. made of reinforced concrete, etc.

It is at this point that a decision needs to be made. If you will need to share, analyze, or present this data, then you will want to collect and store the data in a format that a GIS will recognize. If not, and the data will be used solely as an stand alone application for internal purposes without the need of a GIS, then a simple database may be the most appropriate mechanism for storage and retrieval of your data.

There are several ways to accomplish this. Fortunately, GPS and GIS already speak the same language of "geospatial coordinates". So, communication between the two systems is relatively easy.

For this particular journey I would like to look at using GPS to gather "point data" for a GIS. The reason for this is that it is the easiest path to travel. Data involving lines and polygons can get fairly complex. If you are using GPS to gather information about things that are going to be represented as lines or polygons, I would recommend involving your GIS manager and possibly a cartographer in your project. Even "point" data can become tricky at times. For example: A city at one scale may be a point on the map, but as you "zoom in" that point may cover a large area and become a complex polygon.

Knowing a little bit about what map scales are available for you to use to plot your data is important. With GPS we have at our disposal a tool that can quickly and accurately identify where in the world something is located. Depending on the type of receiver you use and the procedures you follow, the data you collect maybe more accurate than the map you place the information on.

When you start to collect your data you will also need to know what coordinate system to use, such as lat/lon in decimal or degrees, or whether you will use state plane with NAD 83 or NAD 27 as your datum. It is best to involve your GIS support people in the early stages of your project, this will help resolve these type of formatting issue's before you have a heavy investment into your data collection.

Your data collection may very well be the most costly part of your project, so my recommendation is to test, test, and test a sample prior to full scale collection. I've seen to many projects full of either useless or difficult to use data because they were not fully evaluated prior to implementing the collection process. This could have been avoided by simply working together and testing the results before full production. Changes after you have started data collection results in duplication of effort (collecting the same data multiple times) and data desperaity (similar objects described or attributed differently) resulting in a lot of wasted time and money.

In the next issue I will cover confusing issues such as datums and ellipsoids. Till next time, work on your technobabble, surround yourself with geodesists, surveyors, GISers and cartographers. Most of them are really great people if you can figure out what they are talking about.

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